PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

→ DNM
Re IR5840

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 :
F27D 3/14, 23/04, F04F 1/02
// C22B 21/00

A1

(11) International Publication Number: WO 88/ 07165

(43) International Publication Date:
22 September 1988 (22.09.88)

(21) International Application Number: PCT/SE88/00111

(22) International Filing Date: 8 March 1988 (08.03.88)

(31) Priority Application Numbers: 8700966-8
8701514-5

(32) Priority Dates: 9 March 1987 (09.03.87)
10 April 1987 (10.04.87)

(33) Priority Country: SE

(71) Applicant *(for all designated States except US)*:
GRÄNGES ALUMINIUM AKTIEBOLAG [SE/SE];
S-105 45 Stockholm (SE).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)* : KÅGSTRÖM, Per-Olof [SE/SE]; Kalkugnsvägen 10A, S-612 00 Finspång (SE).

(74) Agent: LINDSTRÖM, Bo; Autoliv Development AB, Patentavdelningen, Box 124, S-447 00 Vårgårda (SE).

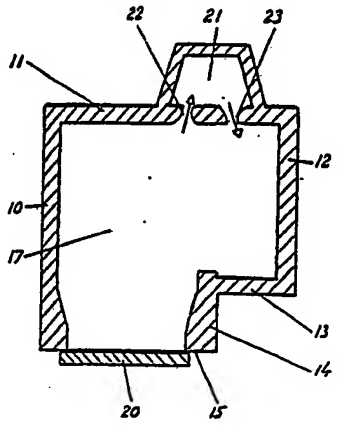
(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US.

Published
With international search report.
In English translation (filed in Swedish).

(54) Title: DEVICE FOR LIQUID PUMPING

(57) Abstract

A device for liquid pumping comprises a pump chamber (21) arranged to receive a subportion of the liquid to be pumped. The pump chamber is provided with means for cyclic variation of the pressure in the pump chamber between an overpressure and a depression with regard to the pressure in the chamber (17) where the main portion of the liquid is. The pump chamber (21) is further provided with an input opening (22) and an output opening (23). The input opening (22) has a substantially lower flow resistance in the direction into the pump chamber (21) than in the opposite direction, and the output opening (23) has a substantially lower flow resistance in the direction out of the pump chamber than in the opposite direction, so that with a depression in the pump chamber a larger liquid quantity is sucked into the pump chamber through the input opening (22) than through the output opening (23) and that with an overpressure in the pump chamber a larger liquid quantity is forced out through the ouput opening (23) than through the input opening (22). Due to this fact a net liquid quantity can be sucked in through the input opening and forced out through the output opening. The device makes it possible to pump many types of liquids, for example molten metal, without the use of movable valves.



Device for liquid pumping

Technical Field

The present invention relates to a device for liquid pumping and comprises a pump chamber which is arranged to receive a subportion of the liquid to be pumped. The pump chamber is provided with means for cyclic variation of the pressure in the pump chamber between an overpressure and a depression with regard to the pressure in the chamber where the main portion of the liquid is. The pump chamber is further provided with at least one input opening and at least one output opening. The device can be used to pump all kinds of liquids, for example for stirring molten metal bodies in connection with holding or degasifying of such bodies, for circulation by pumping of aggressive or corrosive liquids, or for pumping of two liquid states for reducing the risk of emulsion forming.

Background Art

Furnaces for melting of metal, for example aluminium scrab, having means for circulation of the melted charge are previously known. Such furnaces generally comprise a main chamber provided with heating means, generally in the shape of gas or oil burners, for melting heavy material; a side chamber to be charged with small scrab; and a pump chamber for circulation of melted metal between the main chamber and the side chamber. A furnace of this type is disclosed in the Swedish patent publication 8200622-2. In said furnace, controllable pistons are used as valves which open and close openings between the pump chamber and the main chamber or the side chamber for guiding molten metal between the main chamber and the side chamber. However, such controllable pistons are heavily worn in the hard environment in which they work and must therefore be replaced regularly which entails a maintenance cost. Furthermore, the provision of controllable piston valves also entails a comparatively high initial cost for the equipment.

Disclosure of Invention

The main object of the invention is therefore to provide a device for liquid pumping which enables pumping of molten metal as well as pumping of many other types of liquids for stirring or circulation of the liquids without the use of movable piston valves, so that the maintenance costs are reduced to a minimum and also the initial costs are reduced substantially. This object is achieved by giving the device the features set forth in the claims.

Due to the fact that the input opening of the pump chamber has a substantially lower flow resistance in the direction into the pump chamber than in the opposite direction and the output opening of the pump chamber has a substantially lower flow resistance in the direction out of the pump chamber than in the opposite direction, a net quantity of liquid can be sucked in through the input opening and forced out through the output opening by pressure variations in the pump chamber without the use of movable valves.

Due to the fact that the openings are shaped as channels, i. e. have a certain length in the flow direction, a direction dependent flow resistance can easily be provided. This means that the flow quantity per time unit can be made different in the different directions in an easy way. Thus, with a cyclic variation of the pressure in the pump chamber a net flow is obtained in the direction in which the flow resistance is the least.

Brief Description of Drawings

Two embodiments of the device according to the invention will now be further described below with reference to the accompanying drawings.

Figure 1 is a schematical view of a melting furnace of the type set forth in the introduction having a main chamber and a pump chamber in which the input and output openings have been designed according to the invention.

Figure 2 is a schematical view of a melting furnace having a main chamber, a side chamber and a pump chamber in which the openings between the pump chamber on one hand and

the main chamber and the side chamber, respectively, on the other hand have been designed according to the invention.

Figure 3 is a schematic view in a larger scale of the pump chamber according to Figure 1 connected to means for the provision of overpressure and depression in the pump chamber.

Best Mode for Carrying Out the Invention

The furnace, shown in a plan cross section view in Fig. 1, comprises a furnace chamber which besides the bottom and top (not shown) has surrounding walls 10-15. One side wall 15 of the furnace chamber is provided with a removable cover 20 for charging the main chamber of the furnace with heavy aluminium scrab. At the opposite side wall 11 of the furnace, a pump chamber 21 is provided which is connected to the main chamber through channels 22 and 23 in the side wall 11. Thus, molten metal can circulate from the main chamber 17 through the pump chamber 21 back into the main chamber, as indicated by means of arrows. This will cause a stirring of the molten metal, for example for a more equal distribution of the heat supplied to the molten metal or for degasifying the molten metal.

The channels 22 and 23 are designed with successively decreasing flow areas. The channel 22 has its largest flow area at the end facing the main chamber 17 and its smallest flow area at the end facing the pump chamber 21. The channel 23 has its largest flow area at the end facing the pump chamber 21 and its smallest flow area at the end facing the main chamber. Both channels 22,23 have soft rounded edges at the end having the largest flow area and sharp edges at the end having the smallest flow area. Due to this design of the channels, the channels get different flow resistances in different directions. The channel 22 has a substantially smaller flow resistance for molten metal flowing from the main chamber 17 into the pump chamber 21 than for metal flowing from the pump chamber into the main chamber. The channel 23 has a substantially smaller flow resistance for molten metal flowing from the pump chamber 21 into the main chamber 17 than for metal flowing from the main chamber into

the pump chamber.

When the pressure in the pump chamber is lower than that in the main chamber, a larger quantity of molten metal will flow into the pump chamber through the channel 22 than through the channel 23. When the pressure in the pump chamber is larger than that in the main chamber, a larger quantity of molten metal will flow into the main chamber through the channel 23 than through the channel 22. This will cause a net flow of molten metal from the main chamber through the channel 22 into the pump chamber, through the pump chamber and out of the pump chamber through the channel 23, as indicated by means of the arrows in the openings 22 and 23. Thus, due to the cyclic variation of the pressure in the pump chamber and the design of the channels 22,23, a circulation of molten metal is provided in the main chamber.

The melting furnace shown in Fig. 2 agrees mainly with the furnace shown in Fig. 1 and, therefore, the same reference numerals have been used for corresponding parts in the two figures. However, the furnace according to Fig. 2 is provided with a partition 16, so that the furnace chamber is divided into a main chamber 17 and a side chamber 18. The side chamber is connected to the main chamber by an opening 19 in the partition 16. The main chamber is connected to the pump chamber by the channel 22, and the side chamber is connected to the pump chamber through the channel 23 in the side wall 11. The furnace operates in the same way as the furnace according to Fig. 1 with the difference that a net flow of molten metal flows from the main chamber through the pump chamber to the side chamber or possibly from the side chamber through the pump chamber to the main chamber.

As shown in Fig. 3, the pump chamber 21 is provided with a cover 35, so that a closed space is formed. This closed space is connected to a fan 37 through a conduit 36. At the fan, the conduit is divided into two branches 38,39 of which one 38 is connected to the intake side 40 of the fan and the other 39 is connected to the exhaust side 41 of the fan. The intake side 40 of the fan is further connected to

the ambient atmosphere through a conduit 42 and an air filter 43, and the exhaust side 41 of the fan is also connected to a conduit 44 for exhaust air from the fan. The conduits 38,39,42,44 are at the fan provided with throttle valves 45,46,47 and 48, respectively, which may be adjusted by means of a pneumatic control means 49 to close and open the separate conduits. The valves are connected in pairs, so that the intake side 40 of the fan is connected to the conduit 36 to the pump chamber and the exhaust side 41 of the fan is connected to the conduit 44 for discharge of exhaust air from the fan or, alternatively, the exhaust side 41 of the fan is connected to the conduit 36 to the pump chamber and the intake side 40 of the fan is connected to the atmosphere through the air filter 43. In the first case a depression is provided in the pump chamber with regard to the pressure in the main chamber, and in the last mentioned case, which is illustrated in Fig. 3, an overpressure is provided in the pump chamber. The overpressure and the depression, respectively, may be about 0.2 atmospheres with regard to the pressure in the main chamber.

The pump chamber is further provided with a float having a vertically movable floating body 50. The body 50 is attached to a guide rod 51 which is movable in a bearing in the cover 35 of the pump chamber. The top end of the guide rod is provided with an indicator 52 which is arranged to cooperate with a lower and an upper impulse generator 53,54 for indication of a minimum level and a maximum level, respectively, of the molten metal in the pump chamber. The floating body 50 and the guide rod 51 with the indicator 52 are shown in Fig. 3 in an intermediate position.

The impulse generators 53,54 are connected to a control device (not shown) which control the throttle valves 45-48 at the fan to provide a cyclic variation of the pressure in the pump chamber.

Due to the cyclic variation of the pressure in the pump chamber and the above described design of the channels, a net flow of molten metal will flow from the main chamber

through the pump chamber back to the main chamber, alternatively through the side chamber, which causes circulation of molten metal in the main chamber. The cyclic variation of the pressure can occur with a frequency of 1 cycle per minute. With a pump chamber volume of 4 cubic metres this will give a pumping capacity of about 2-3 tons of aluminium per minute.

While only two embodiments of the device have been shown and described, it is obvious that many modifications and variations are possible within the scope of the invention. For example, the pump chamber must not necessarily form a unit together with the main chamber but may form a separate unit which can be connected to the main chamber by means of suitable conduits. The channels between the pump chamber and the main chamber may have a decreasing flow area along only a portion of the full length of the channel or along the full length of the channel and for example have the shape of a trumpet or a truncated cone. The edges of the channels at the end where the flow area is largest may be tapered in stead of rounded. The edges of the channels at the end where the flow area is smallest may be more or less sharp. The sharper the edges are, the higher is the flow resistance for the liquid flowing into the channels at the sharp edges. The channels may also completely or partly consist of inserted tube portions which project from the wall and thus form a sharp edge at the channel end where the flow area is smallest. The channels may then easily be made longer and may form an angle with the wall through which they run. The channels may then also be designed with several sections, if necessary to obtain the desired difference in flow resistance between the different directions. In stead of designing the channels with a decreasing flow area the channels may be designed to give turbulence or disturbances in the flow which are different for different flow directions, so that in this way different flow resistances in different directions are obtained. This may be provided by means of one or more inserted means in the channels. Finally, in certain cases it may be sufficient

that only one opening is designed as a channel with different flow resistance in different directions to obtain some circulation through the pump chamber. However, the pump power and consequently the circulation of liquid are less than if several channels with different flow resistances are used. It is, of course, also possible to provide several input openings or input channels and several output openings or output channels to and from, respectively, the pump chamber and give these openings or channels different flow areas. However, essential is that the openings or channels and their flow resistances are designed in such a way that a net quantity of the liquid is fed through the input and output openings, so that a net flow is obtained through the pump chamber.

Claims

1. Device for liquid pumping, comprising a pump chamber (21) which is arranged to receive a subportion of the liquid to be pumped and which is provided with means (36-49) for cyclic variation of the pressure in the pump chamber between an overepressure and a depression with regard to the pressure in the chamber (17) where the main portion of the liquid is, the pump chamber (21) further being provided with at least one input opening (22) and at least one output opening (23), characterized in that the input opening (22) has a substantially lower flow resistance in the direction into the pump chamber (21) than in the opposite direction and that the output opening (23) has a substantially lower flow resistance in the direction out of the pump chamber than in the opposite direction, so that with a depression in the pump chamber a larger liquid quantity is sucked into the pump chamber through the input opening (22) than through the output opening (23) and that with an overpressure in the pump chamber a larger liquid quantity is forced out through the output opening (23) than through the input opening (22), so that a net liquid quantity is sucked in through the input opening and forced out through the output opening.

2. Device according to claim 1, characterized in that the openings are designed as channels (22,23) having less flow resistance in one direction than in the other direction.

3. Device according to claim 2, characterized in that each channel (22,23) has a flow area decreasing in the main flow direction.

4. Device according to claim 3, characterized in that the channels at the end where the flow area is largest have bevelled edges.

5. Device according to claim 4, characterized in that the channels (22,23) at the end where the flow area is largest have soft rounded edges.

6. Device according to any of claims 3-5, characterized in that the channels (22,23) at the end where the flow area is

least have sharp edges.

7. Device according to any of claims 3-6, characterized in that the flow area of each channel (22,23) continuously decreases along at least a portion of the length between the ends of the channel.

8. Device according to claim 7, characterized in that the flow area of each channel (22,23) decreases continuously along the full length between the ends of the channel.

9. Device according to claim 1 or 2, characterized in that each opening is designed to cause turbulence for a flow in one direction but not in the opposite direction.

10. Device according to claim 9, characterized in that at least one channel is provided with inserted elements causing turbulence.

11. Device according to any of the preceding claims, particularly in melting furnaces of the type having a main chamber (17); a side chamber (18) connected to the main chamber through an opening (19) in a furnace wall (16); and a pump chamber (21) connected to the main chamber as well as to the side chamber through at least one opening (22,23) to each chamber in a furnace wall (11) and provided with means (36-49) for cyclic variation of the pressure in the pump chamber between an overpressure and a depression with regard to the pressure in the main chamber, characterized in that at least one of the openings (22,23) between the pump chamber (21) and the main chamber (17) and the side chamber (18), respectively, is designed as a channel (e.g. 22) in such a way that the flow resistance is less in one direction than in the other direction, so that with a depression in the pump chamber (21) more molten metal is sucked into the pump chamber from one (e.g. 17) of the two chambers (17,18) and with an overpressure in the pump chamber more molten metal is forced from the pump chamber into the other (18) of the two chambers, so that pumping of molten metal in the direction from the main chamber to the side chamber or in the opposite direction is provided.

12. Device according to claim 11, characterized in that all

openings are designed as channels (22,23) having less flow resistance in one direction than in the other direction and that the channels (22,23) are so related that the flow resistance in all channels are less either in the direction from the main chamber through the pump chamber to the side chamber or in the opposite direction.

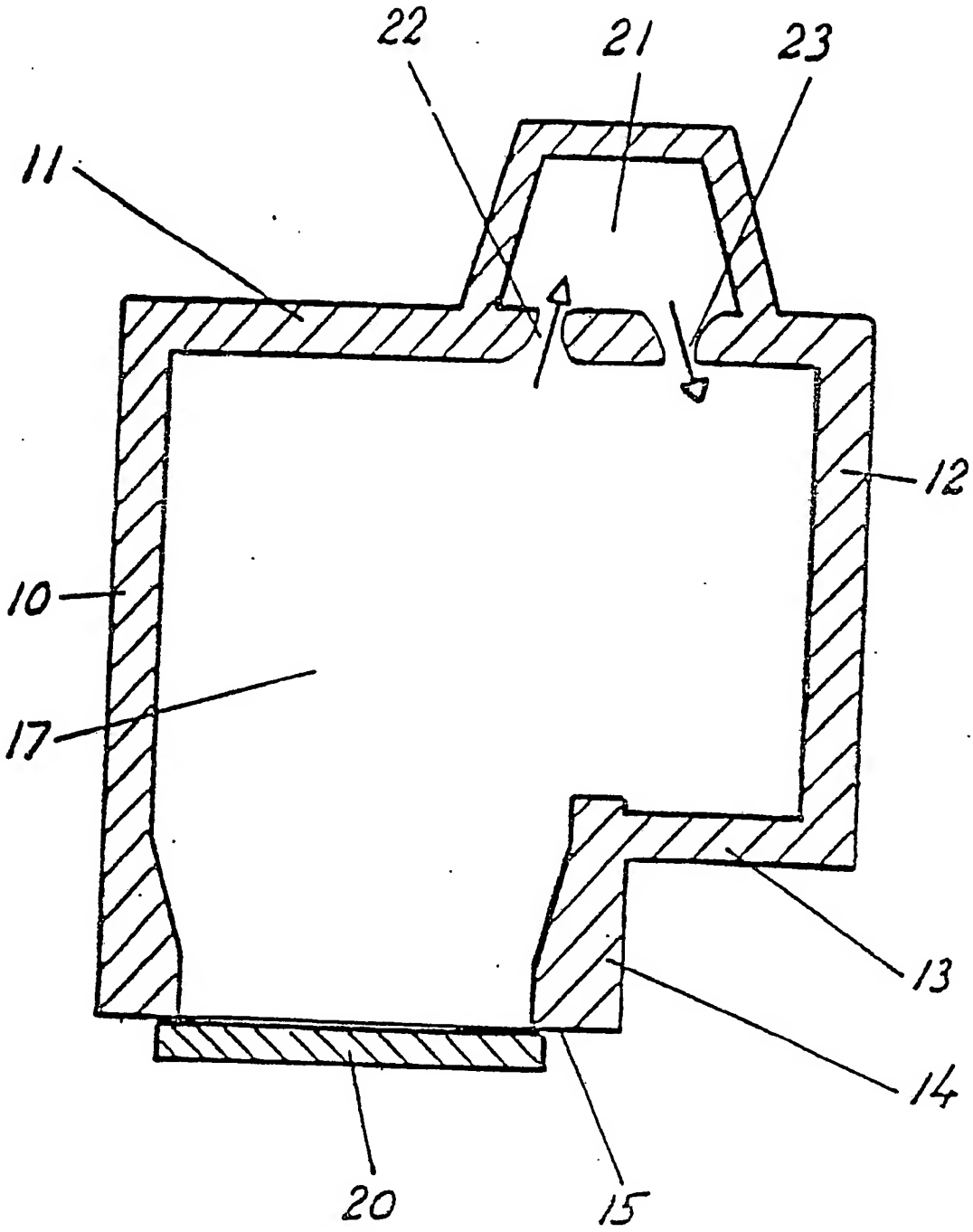


FIG 1

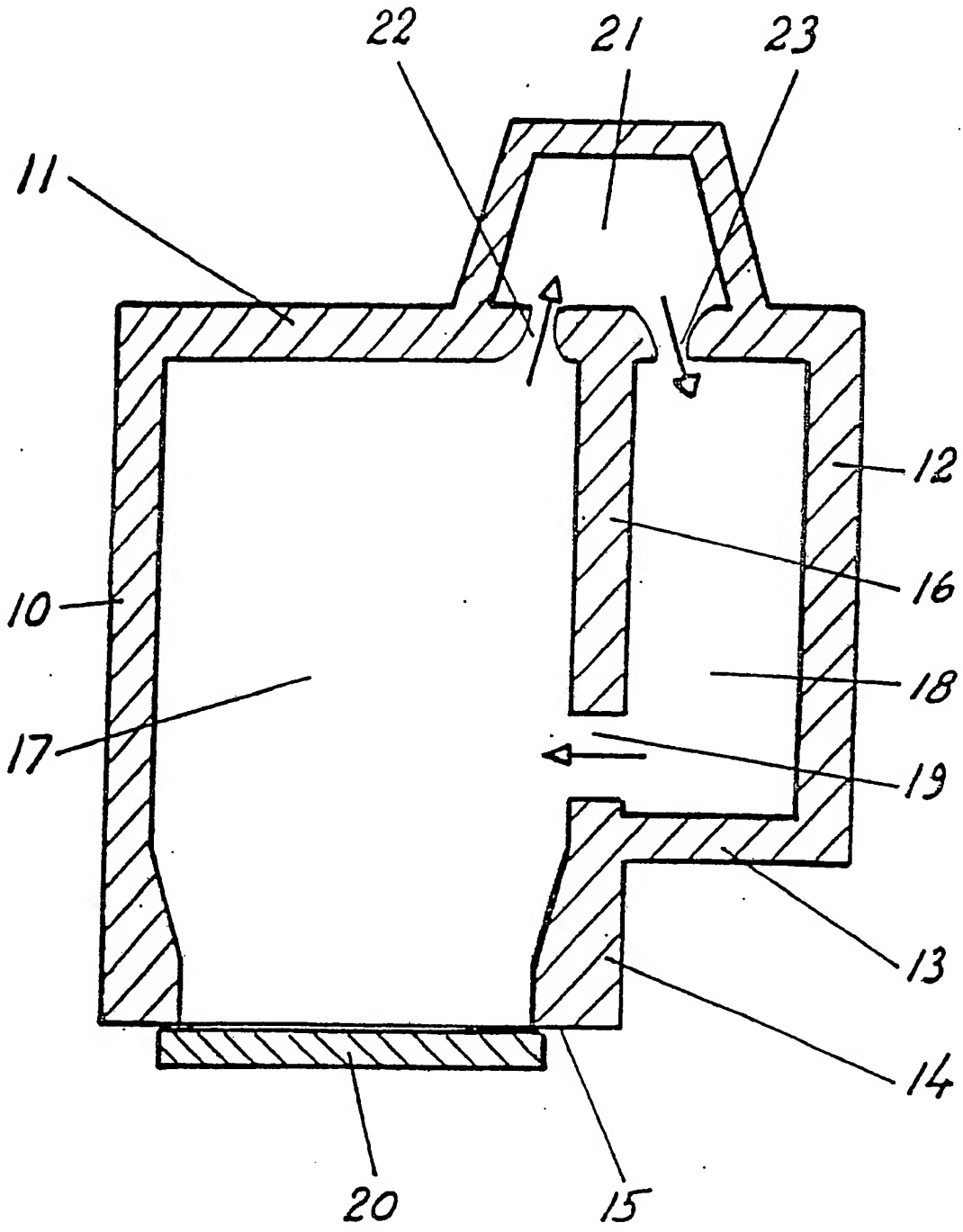


FIG 2

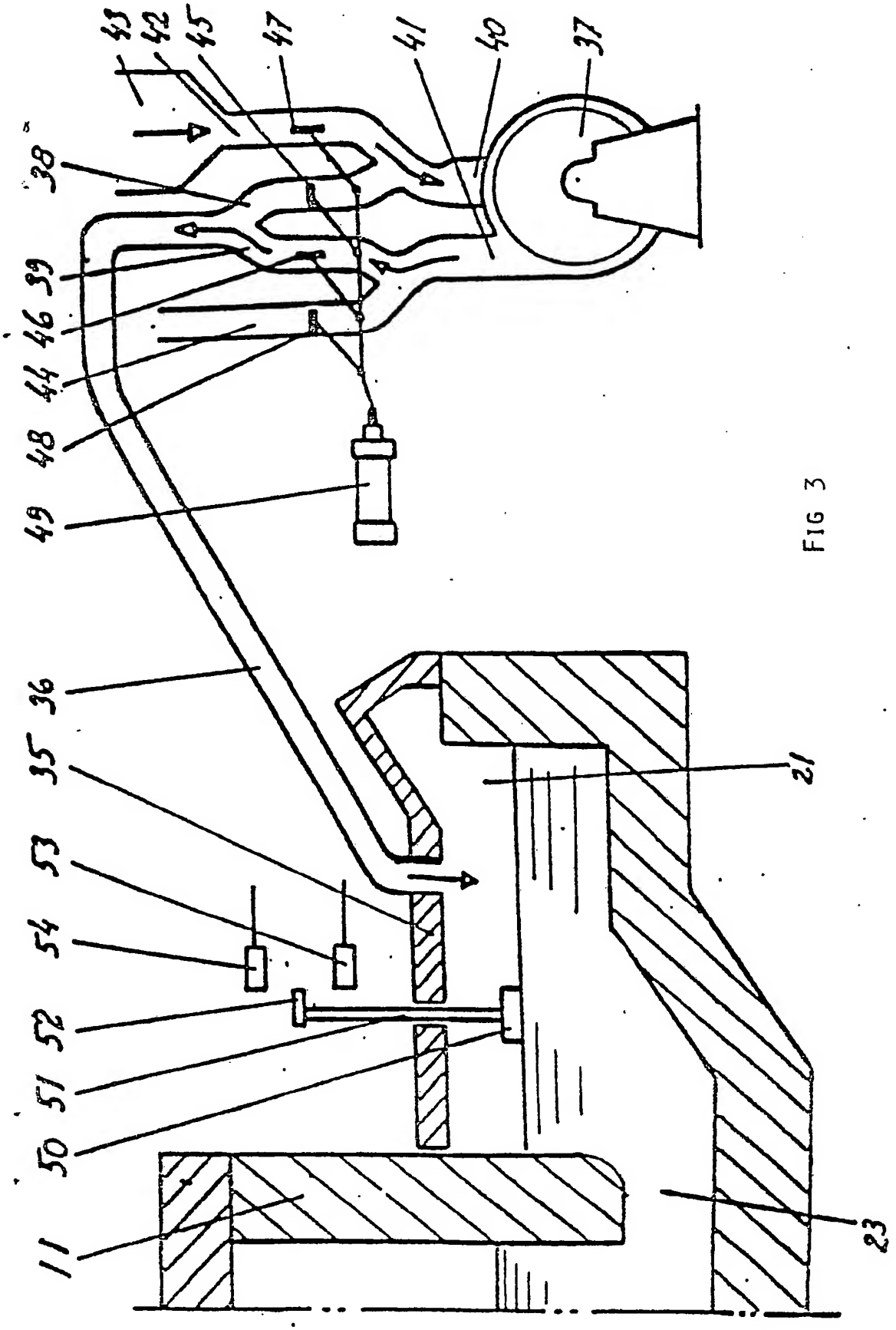


FIG 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE88/00111

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

F 27 D 3/14, F 27 D 23/04, F 04 F 1/02 // C 22 B 21/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	F 04 F 1/02; F 04 B 7/04,/06, 17/04; F 15 D 1/00,/08; F 04 D 35/00; C 22 B 9/00,/04, 21/00,/06; F 27 B 3/04,/19, 14/04,/18; F 27 D 3/14, 7/04, 23/04 .../...

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	SE, B, 449 790 (GRÄNGES ALUMINIUM AB) 18 May 1987	1-12
A	US, A, 3 973 763 (STEINKE ET AL) 10 August 1976	1-12
A	US, A, 4 355 789 (DOLZHENKOV ET AL) 26 October 1982	1-12
A	US, A, 4 518 424 (ORMESHER) 21 May 1985	1-12

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1988-05-27	1988 -06- 01
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	Mårten Hulthén

Form PCT/ISA/210 (second sheet) (January 1985)

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II Fields searched (cont)

US Cl 13:31;
75:65, 68;
266:160-162, 166, 207-210, 233, 236, 239, 266;
417:149, 417

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers ....., because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers ....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers ....., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.